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Electric motors for the farm

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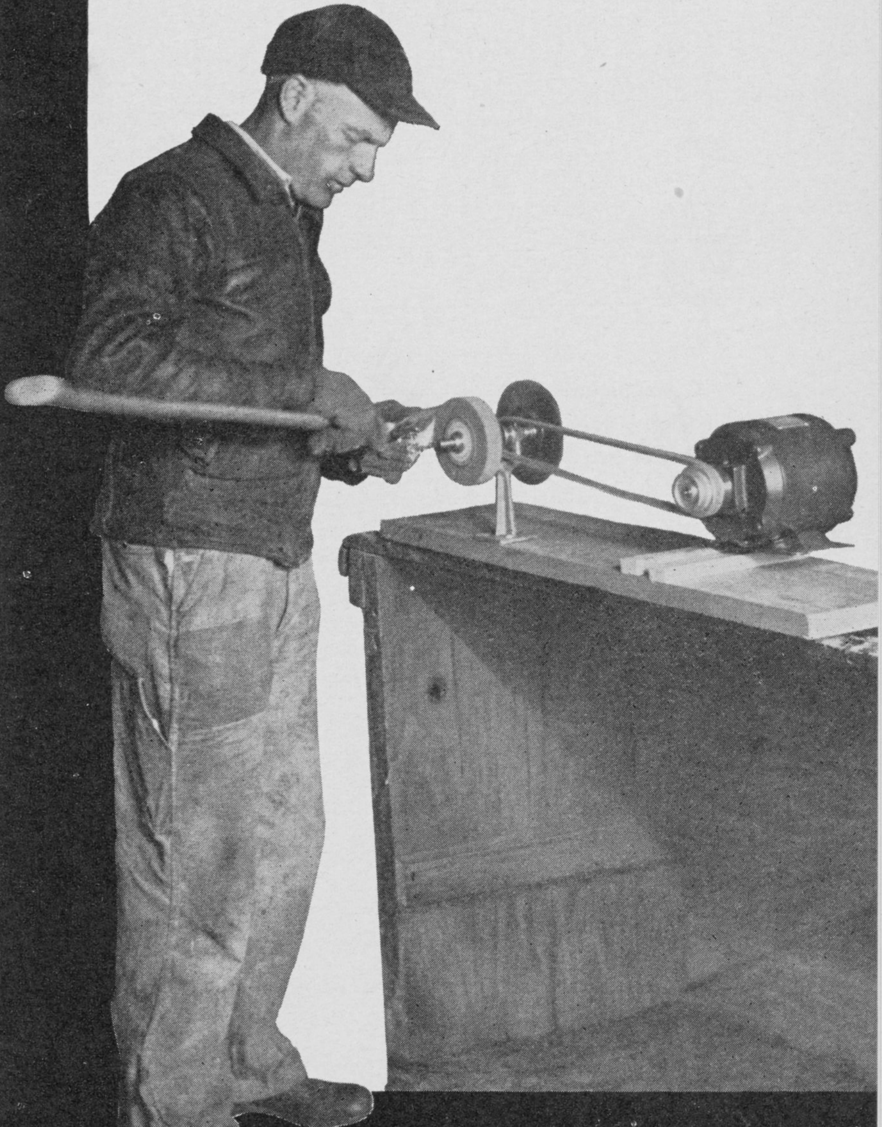
ELECTRIC MOTORS FOR THE FARM



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Cover picture: This ¼-horsepower motor will not tire as it turns the grinder. Note method of mounting. The two wood cleats, a broomstick and two ¼″ x 1¼″ bolts provide a simple, inexpensive mounting.

CONTENTS

SUMMARY

1. Electric motors are readily adapted to automatic control.

2. Electric motors have long life with a minimum amount of care.

3. Electric motors possess the ability of developing two or three times their rated output for short periods of time.

4. A 1/6 or ¼-horsepower motor will do as much work as a man when operating a crank.

5. A portable motor can be used for those machines used seasonally.

6. Two portable motors, ¼ to ½ horsepower and 3 to 7½ horsepower will operate practically all the farm machines not supplied with an attached motor.

7. Individual motors should be used on those machines that are used daily, such as water pumps, cream separators, milking machines, etc.

8. Line shaft drives are not recommended for electric motors.

9. Motors should be kept well lubricated. Excessive lubrication, however, is not desirable.

10. Motors have longer life if they are kept clean and dry.

11. Pliable belts will give greater satisfaction than stiff, heavy belts.

12. Fuses may not provide adequate protection. Special fuses or built-in motor protection devices will often save the cost of a new motor.

13. Operate electric motors on the proper voltage and not more than 10 percent different from the name plate rating.

Electric Motors for the Farm*

(Single Phase)

By H. H. Beaty[1] and W. A. Thomas[2]

A quarter-horsepower motor can operate any machine that can be manually operated by an able-bodied man. Such a motor can drive any farm machine ordinarily turned by hand at a cost of about 1 cent per hour for electricity.

A 1/4-horsepower motor costs from $5 to $18; a good reliable heavy-duty motor costs only $11.50, and it will last for many years. In this time it will do dozens of chores such as pumping water, turning separators, grinding corn, driving fanning mills and shelling corn.

With proper care electric motors will give years of low-cost, trouble-free service, but with improper care a motor may wear out in a year or burn out in a few minutes. Unlike a gasoline engine which stalls when overloaded, the electric motor will continue to do work even when overloaded and run until its winding insulation goes up in smoke.

Selection

The selection of motors for farm use must take into consideration the type of electric power available, the kind of work to be done and the size of the machine to be driven.

Direct current motors of the 32-volt variety will not operate on alternating current as supplied by the high lines. Single phase motors (having only two leads into them) are commonly selected for service on farms supplied by electric service lines. A few farms have three phase power available, but this would be necessary only when large 10 to 25-horsepower motors are used. The single phase motor can be used from small sizes up to 5 or 7 1/2-horsepower (this maximum size would be determined by the power company). Some power

*This publication is devoted to single phase alternating current motors. A number of the photographs are furnished by the courtesy of Westinghouse Electric and Manufacturing Company and Century Motor Manufacturing Company.

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companies will permit the connection of a 10-horsepower motor but only with special starting equipment.

The motors of various manufacturers are standardized as to sizes, voltage, speed and types and usually to base and pulley dimensions. Motors can be purchased in sizes of 1/6, ¼, ½, ¾, 1, 2, 3, 5 and 7½ horsepower, usually in either 1750 or 1165 r.p.m. and for either 110 or 220 volts. Sometimes other motor sizes are available in addition to these.

Fig. 1. Feed grinder supplied from overhead bins being operated by a 3-horsepower portable motor.

Iowa State College is often asked to recommend the motors of various manufacturers. For obvious reasons this cannot be done, and although the college has frequent occasion to test various motors it does not make a practice of testing all motors that are manufactured. Reputable manufacturers build good motors which meet certain minimum standards established by electrical engineering organizations. All motors will carry some overload, but some motors have a higher factor of safety than others. Only by test can one be sure of how much extra power the motor has. All motors distributed nationally are good, but the user will probably be repaid if he buys the best motor of the type which he desires.

Two portable motor units, one ¼ or ½ horsepower and one 5 or 7½ horsepower will usually take care of all the farm machinery not provided with attached motors. It is important to select the proper voltage rating.

Types of Motors

All single phase motors operate on essentially the same principle, but the method of operation need not concern the motor user. The motors of various types differ chiefly in their ability to start loads or in starting torque. For different uses (see table) various starting torques are needed. A number of different starting methods are used. Single phase motors have been named after these different methods.

Six different types of motors are commonly manuufactured for single phase alternating current. They are:

1. Split-phase
2. Capacitor start-induction run
3. Capacitor run
4. Repulsion start-induction run
5. Repulsion induction
6. Universal

The first five mentioned have essentially the same operating characteristics after they are started, but they differ very much in starting ability. The capacitor run motor is an especially fine new type of motor without starting winding or centrifugal switch, but it is also more expensive. It can be used on a cream separator without a clutch and in this way save a great

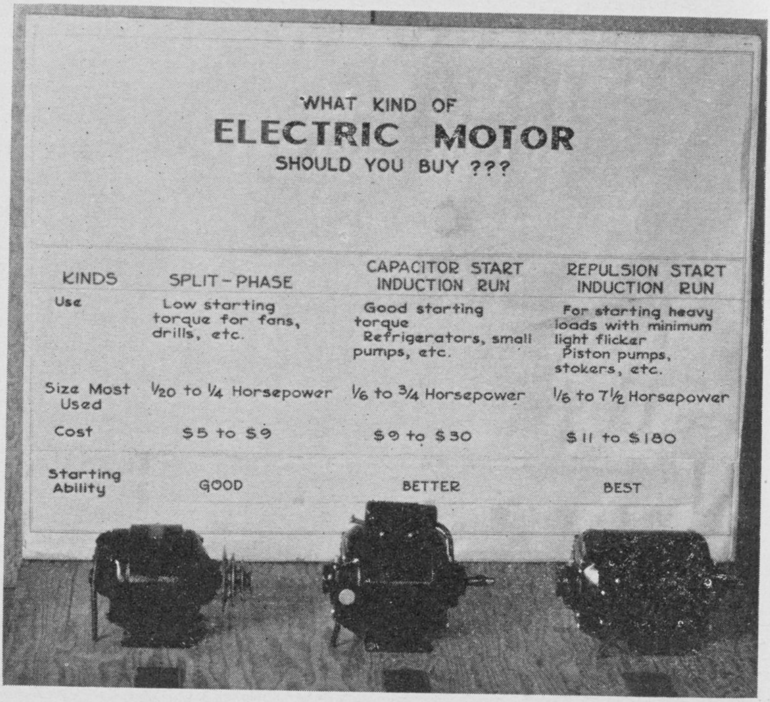


Fig. 2. Three of the common types of single phase motors, split-phase, capacitor start-induction run and repulsion start-induction run are illustrated above, together with a brief summary information relative to use, size, cost, care, voltage and starting ability.

deal of money. The sixth motor, the universal, is a high speed motor which operates on either direct or alternating current and is used chiefly for vacuum cleaners, food mixers, etc.

Starting Ability

The first five motors listed above are in order of their starting ability, the split-phase motor having the least starting ability. It is also the lowest priced motor and is used to operate washing machines, fans, saws, drills and other equipment that requires little starting torque. For general portable use around the farm this motor should not be used. This motor would, in general, start only 90 percent of its rated load and would drive about 180 percent of its rated load without stalling. This overload would soon burn out the motor.

The capacitor start-induction run motor is a newer type and will cost about 20 percent more than the split-phase. This motor has good starting characteristics as it will start 200 percent of its rated load and will carry 200 percent without stalling. It is rapidly replacing the other type for refrigerators, small water pumps, stokers and similar applications. For such applications as these it is an ideal motor.

The repulsion start-induction motor is used where hard-to-start equipment is to be operated, as it will start 350 percent and speed up 200 percent of its rated load. It will also carry 200 percent of rated load without stalling but will burn out in a few minutes on this load. This motor is commonly purchased for jobs requiring ½ horsepower and larger size motors. Examples of the use of this motor are given in table 1.

The repulsion induction motor has very good starting ability and will bring up to full speed any load it can start. Its other characteristics are similar to the repulsion start-induction motor.

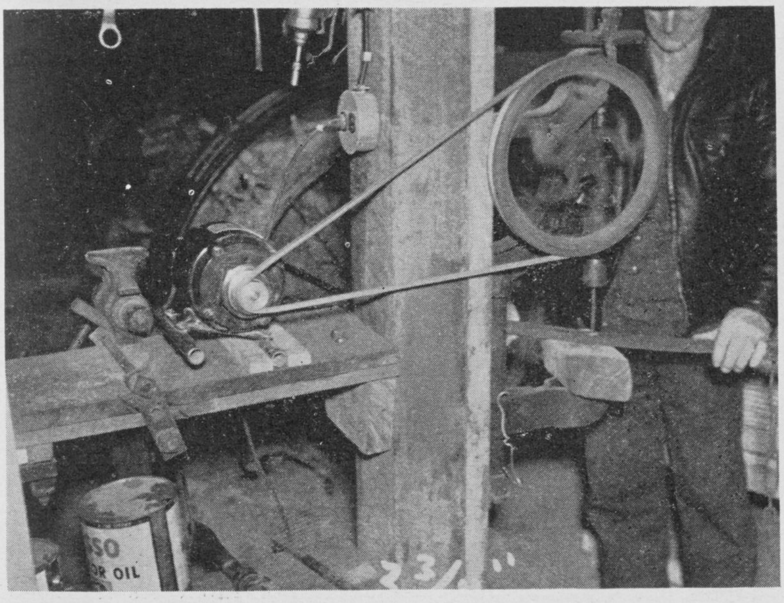


Fig. 3. Post drill converted to electric motor operation.

TABLE 1. MOTOR SIZES AND TYPES

	Motor sizes	Most used	Motor type
Cream separator	1/6 to 1/4	1/6	Repulsion induction or capacitor run
Washing machine	1/6 to 1/4	1/4	Split-phase
Fanning mill	1/4 to 1/2	1/4	Repulsion start-induction run
Fruit and vegetable graders	1/4 to 1/2	1/4	" " " "
Sausage grinder	1/4 to 1/2	1/4	" " " "
Milking machine	1/4 to 1	1/3 to 1/2	" " " "
Corn sheller (one hole)	1/4 to 1/3	1/4	" " " "
Small concrete mixer	1/4 to 1/2	1/2	" " " "
Emery wheel	1/4 to 3/4	1/4	" " " "
Feed grinder	1 to 10	5	" " " "
Grain elevator	2 to 5	3	" " " "
Ensilage cutter	5 to 10	7½	" " " "
Hay hoist	3 to 10	5	" " " "
Feed mixer	3 to 7½	5	" " " "
Wood saw	5 to 7½	5	" " " "
Churn	1/6 to 1/4	1/4	" " " "
Pump jack	1/4 to 1/2	1/3	" " " "
Drill press	1/8 to 1/2	1/4	" " " "

Application

Table 1 is useful for selecting motor sizes. Be sure to use the proper voltage.

The capacitor motor is commonly sold in sizes up to ¾ horsepower and is used for applications listed as for repulsion start-induction motor. The repulsion induction motor can also be used in all applications listed.

Voltage

It is very important that electric motors be operated at the voltage specified on the name plate. This means buying the proper voltage motor and being sure your line voltage is within 10 percent of this amount. Over voltage will do almost no harm. Split-phase and capacitor motors are usually used on 110 volts but can be purchased in 220-volt size.

Repulsion start-induction run motors may operate at either 110 or 220 volts. Changing the terminal block connections enables operation at either voltage. For 220 volts the coils should be in series and for 110 volts the coils should be in multiple or parallel. Motors of ½ horsepower and larger should be operated at 220 volts.

Questions are sometimes asked about the speed of motors. Small motors are generally 1750 or 1165 r.p.m. The lower speed motor gives greater turning effort for the same horsepower size. The slower speed motors are larger and considerably more expensive.

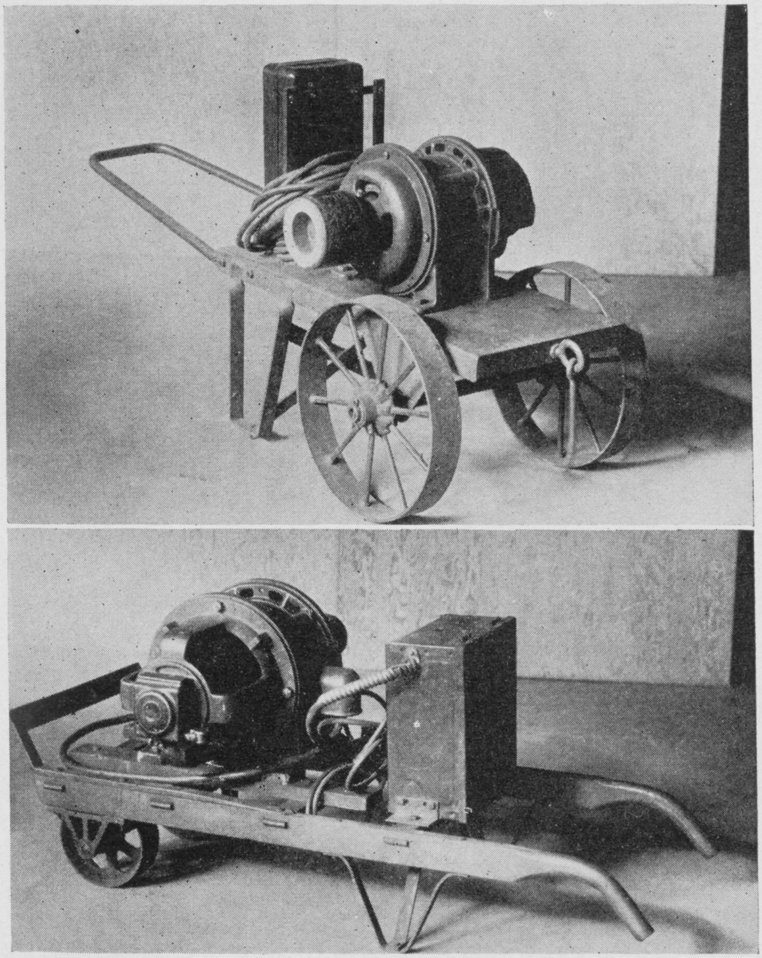


Fig. 4. Electric motors can be made portable either by commercial or homemade mounting. A number of farm machines such as grain elevator, wood saw, feed grinder can be operated by 3 to 7½-horsepower electric motors.

Operation

Electric motors require little attention. With reasonable care they will last for years. They start readily under average temperature conditions, cold weather presenting no extra hazard. The convenience thus afforded often influences farmers to use electric motors for grinding feed and elevating grain.

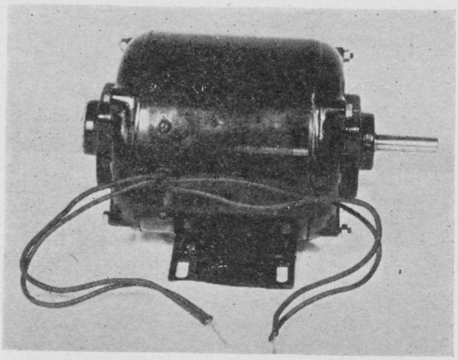


Fig. 5. Repulsion start-induction run and repulsion induction motors can be operated on either 110 or 220 volts. Above connections are for 110 volts. The motor leads are parallel. Be sure to follow the manufacturer's directions in changing connections.

Sometimes low-torque motors will blow fuses when first starting on cold days when oils and greases in machinery are stiff.

When using a portable motor be sure that the bearings have oil when running, for often the oil is spilled in moving the motor about. Small motors which have a yarn-type oil reservoir are not inflicted with this difficulty. The sleeve-type bearing is perfectly satisfactory for general use, but ball bearing motors are available at higher costs. The ball bearing motors are quieter in operation and have grease permanently sealed in.

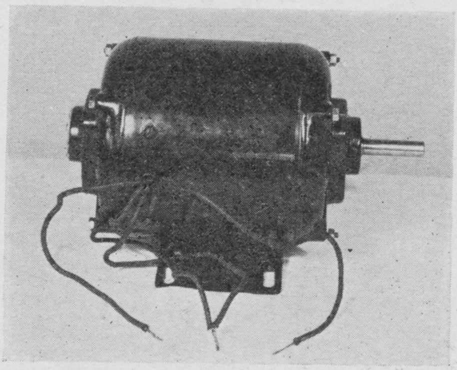


Fig. 6. Showing proper connections for 220-volt single phase repulsion induction and repulsion start-induction run motor. Motors of ½ horsepower and larger usually operate more efficiently on 220 volts.

The conventional electric motor is quite satisfactory for general farm use. The cost will be less, the life quite as good and operation just as satisfactory as special motors such as the enclosed, drip-proof, splash-proof or explosion-proof motors. These motors have enclosed frames so that dust, liquids or gases will not damage the windings or explode. They are used in dusty or wet locations in mills or factories. However, if the farmer expects to run his motor in the rain a drip-proof, enclosed motor would be needed.

Operating experiences on typical farms indicate that overloading, poor or insufficient lubrication, worn bearings, improper circuit protection (fusing), lightning and operating in dusty and wet surroundings are the principal causes of motor failures. When heavily overloaded an electric motor will burn up quickly, although it will usually give sufficient warning by overheating or smoking. An electric motor cannot protect itself by stalling as the gasoline engine does.

Motor Efficiency

The efficiency of electric motors varies with the horsepower rating. Small fractional horsepower motors are less efficient than motors of 1 horsepower and larger.

TABLE 2.* INPUT IN WATTS AND EFFICIENCY FOR 1,725 R.P.M., 60-CYCLE, SINGLE PHASE FRACTIONAL HORSEPOWER MOTORS

(Split-phase motors)

Horsepower	Volts	Efficiency	Input in watts
1/30	110	21%	80
1/20	"	35%	107
1/10	"	44%	170
1/8	"	50%	186
1/6	"	48%	259
1/4	"	55%	339
(Repulsion start-induction motor)			
1/8	110/220	42%	222
1/6	"	47%	265
1/4	"	54%	345
1/2	"	59%	632
3/4	"	62%	902

*Source: General Electric Co.

TABLE 3. *EFFICIENCY OF A 5-HORSEPOWER ELECTRIC MOTOR AND ITS RELATION TO THE LOAD.

Percent load	Percent brake efficiency
25	47
50	66
75	73
100	74
125	75
150	74

*Source—Westinghouse Electric and Manufacturing Company.

The rating of a motor is for continuous operation and is based on motor heating. A motor will usually carry a 25-percent overload for 2 hours or 50-percent overload for ½ hour safely. For intermittent duty the user must use his judgment on overloads. A motor cools faster running light than it does when stopped.

Care of Motor

Electric motors should be kept clean and dry. Water is very harmful to electrical wiring, and if a motor is submerged or thoroughly wet it should be carefully dried out before being put back in service. The moisture will not harm the motor if reasonable precautions are taken in drying before use. In this connection, in case of fire in electrical wiring or motors use a carbon dioxide (lux) or sand-type fire extinguisher instead of water or a sulfuric acid extinguisher.

Motors should be oiled according to directions with a good grade of light mineral (petroleum) oil using S.A.E. 20 W. in temperatures 0° F. to 32° F. and S.A.E. 30 W. in temperatures 25° F. to 150° F. An even thinner oil can be used below 0° F. Oil chambers should be filled to the proper level when the motor is not running, and it would be well to make a routine oil check every time a portable motor is used. Oil should not be spilled on the commutator, brushes or motor windings, and too much oil may cause an oil spray on these parts. The oil chamber can be drained by removing the plug at the bottom of the chamber and cleaned by flushing with gasoline or kero-

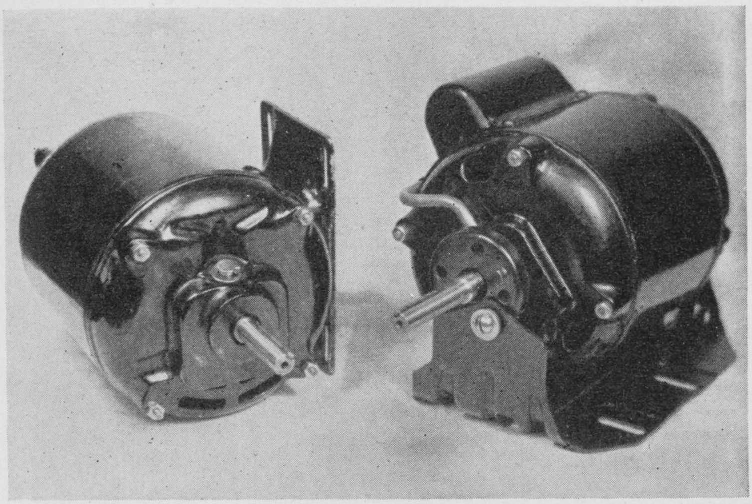


Fig. 7. Electric motors are provided with a variety of mountings. The mounting for motor (right) above is insulated from the motor frame by a rubber gasket. This provides extra protection from shock hazard and eliminates noise and vibration. Washing machine motors should have this protection. The conventional single phase motor may be mounted on posts or on the wall by loosening and shifting the end bells so that oil chambers are in the proper position. See (left) above.

sene. This cleaning out should not be necessary except when the oil chambers become clogged with dirt. When motors are operated in dirty places special attention should be given to cleaning and oiling.

Regular inspections and reasonable care should be made, and for this attention the motor user will be amply repaid. Motors not equipped with oil chambers (small motors usually have a yarn-type oil packing) should have a few drops of light oil semiannually.

Life

Electric motors are built for floor mounting and if mounted otherwise, precautions must be taken to insure lubrication. This may require a shifting of the end bell to level the oil chamber.

If given proper care an electric motor may be expected to last for 25 to 30 years.

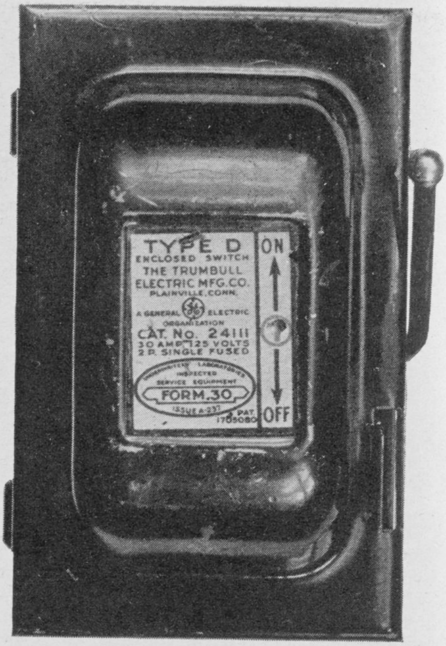
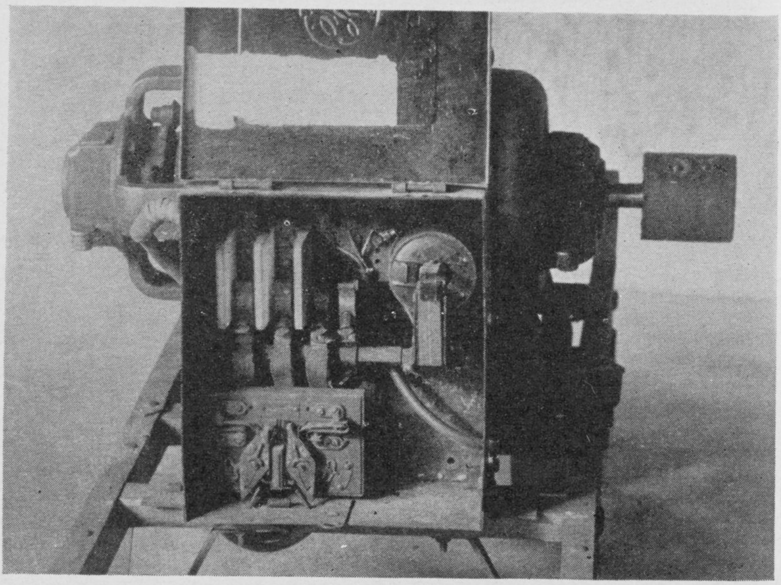


Fig. 8. Starting switches for motors vary from the simple single pole switch (right) to the complicated magnetic push button controlled switch (below). Note the simple thermal type of motor protecting device (above), a combined switch and overload protection available at a low cost of \$1.25 to \$2.50 and capable of giving adequate protection for motors from 1/6 horsepower to 1 horsepower in size.



Motor Controls or Starting Devices

Two types of controls are used for farm motors. They are manually and magnetically operated. Manual starting devices for motors usually consist of knife switches equipped to open the circuit quickly to prevent arcs that might burn the switch blades. This type of manual switch is totally enclosed, except for the operating lever, in order to prevent fire hazards from the arc. The farm user should realize that to use open-type knife switches is inviting danger to life and exposing needlessly a fire hazard.

The motor starting switches should be kept dry and in good repair. If switches are allowed to have loose or broken parts or if allowed to become wet, they endanger life due to leakage through the damaged parts.

Magnetic starters perform the same function as knife switches. Magnetic switches, however, may be operated by remote control push buttons. The magnet merely operates to close contacts for starting the motor.

Larger motors may use resistances or auto-transformers to reduce the starting voltage. These units reduce the power demand on the circuit and permit the operation of the larger motors.

Fuses and Thermal Relays or Overload Devices

Simple plug or cartridge fuses will not give complete protection for electric motors. Such fuses usually protect the wiring system against short circuits only. An electric motor fused high enough so that the motor can start without burning the fuse will have no protection against overload. The starting current is many times the overload current. In a split-phase motor the starting current is five to seven times the running current, and in a repulsion start-induction run motor the starting current is three to five times the running current. Thus fuses must be larger to enable the motor to start, but they offer no protection against overheating.

Time-delay fuses or circuit-breaker type of thermal relays should be used to protect the motor since they do not operate instantaneously as do conventional fuses. The motor user will be amply repaid if he equips his motor with a thermal-type overload device. The cost will be small and will permit the operator to forget about overloading danger. The relay will stop the motor when it is too hot.

For continuous or automatic operation of a motor, overload protection devices rated at 125 percent of the current marked on the name plate should be used. A time-delay protection of this amount will permit starting and also will protect against continual overload. For example a ¼-horsepower motor rated at 4 to 5 amperes should be protected with a built-in motor protection device or by a time-delay fuse similar to the Buss Fusestat of a 6 to 7-ampere rating.

A built-in motor protection is a guarantee of safety for the motor and should receive full consideration by prospective purchasers.

Almost as important as overload is the question of undervoltage. The power seller should supply you proper voltage, but at times your voltage may be low because of high load or line trouble or unusually high loads at your farm. The motor power is greatly reduced by undervoltage and may burn out even on its usual load. The same protection devices mentioned above would prevent this. Sometimes undervoltage will prevent a motor from getting completely up to speed. When starting a motor be sure that it gets up to speed and you hear a click in its operation. This click is caused by a centrifugal device which disconnects the starting windings of split-phase motors and lifts the brushes on repulsion start motors.

Fig. 9. The direction of rotations of capacitor and split-phase motors may be changed by disconnecting the leads, interchanging and reconnecting leads to the binding posts.

Changing Direction of Rotation

Split-phase and capacitor motors. Reversing the connections of the starting winding will cause split-phase and capacitor motors to change their direction of rotation. It will be noted that these motors have terminal blocks to which the two leads of main winding and two leads of starting winding are connected (the starting winding consists of a few turns of fine wire located in the top of the motor slots). In order to reverse the motor the two starting winding leads are disconnected, reversed and reconnected to the terminals. Some motors are provided with switches which will automatically reverse the motor.

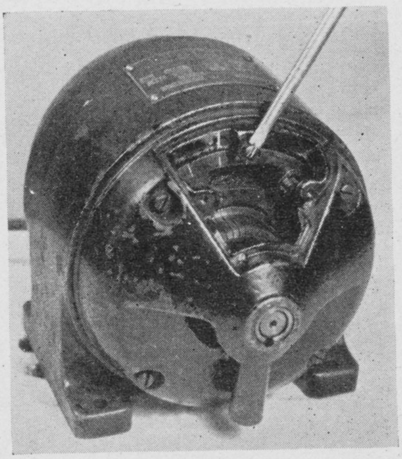


Fig. 10. The rotation of repulsion start-induction run motors may be changed by unloosening screw in brush holder yoke and shifting position of brush holder. Care must be exercised to align brush holders with marks on yoke and on motor frame.

Repulsion Induction. Changing the position of the brushes will cause the direction of the rotation to be reversed. The brushes are mounted on a rocker arm which may be moved by hand when the holding screws or nuts are loosened. Usually the proper brush position is marked, and by moving the brushes in the direction of the rotation desired reversal is obtained. The brushes need be moved only a short distance on the commutator, and it is best to do this by trial.

Belts and Belt Speeds

Since electric motors operate at relatively high speeds, normally 1,165 to 1,750 r.p.m. belts should be light and pliable. Canvas and rubber belts up to four-ply thickness and leather belts of two-ply or less are considered acceptable. Heavy stitched canvas and stiff leather belts are not satisfactory. Endless belts are more satisfactory than laced belts. Too high

Fig. 11. Special sickle grinder driven by ¼-horsepower motor.

belt speeds are not desirable, 4,000 feet per minute being nearly maximum. A motor operating at 1,750 r.p.m. should not use a drive pulley larger than 8½ to 9 inches. "V" belts are usually more satisfactory than flat canvas or leather belts.

Pulley Size

Pulley sizes may be calculated from the following consideration: The diameter of the driver (motor) pulley multiplied by the speed of the driver (motor r.p.m.) equals the diameter of the driven multiplied by the speed of the driven (r.p.m.). Example: A motor operating at 1,750 r.p.m. will require a 3-inch pulley to drive a corn sheller at 210 r.p.m. when the corn sheller pulley is 25 inches in diameter (3x1,750=25x210).

Repairs

A motor will require little in the way of repairs if properly operated. The brushes may need replacing after several years' use, and the commutator may become rough, needing smoothing with light sandpaper. After a period of years the commutator may need to be trued in a lathe. Worn bearings may cause trouble, as the clearance between rotor and stator is very slight. Burned-out motors may be repaired in electrical shops. Rewinding small motors may cost more than the replacement cost of a new motor. Properly rewound motors are practically as good as new motors.

Motor Troubles and Remedies*

Split-Phase and Capacitor Start-Induction Run Motors

(A) Failure to Start—Probable Cause:

1. Blowing of fuses or operation of overload device.
2. No voltage or low voltage.
3. Open-circuited field.
4. Improper current supply. Incorrect voltage or frequency.
5. Condenser short-circuited or open-circuited.
6. Impoper line connection.
7. Excessive load.

*These Troubles and Remedies are similar to a chart published by the Wagner Electric Co., St. Louis, Mo.

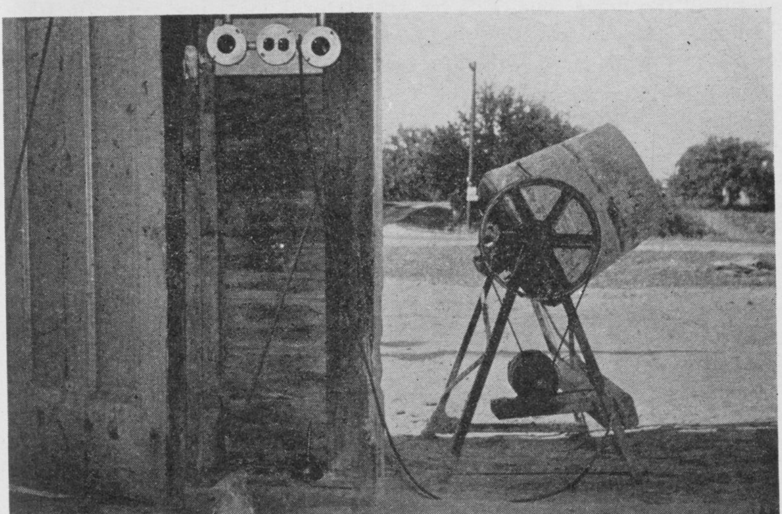


Fig. 12. Small cement mixer powered with ¼-horsepower motor.

(A) Failure to Start—Test and Remedy:

1. Examine motor bearings, be sure that they are in good condition and properly lubricated. Be sure motor and driven machine both turn freely. Check circuit voltage at motor terminals against voltage stamped on motor name plate. Examine overload protection of motor. Overload relays operating on either magnetic or thermal principles, or a combination of the two, offer adequate protection to the motor. Ordinary fuses of sufficient size to permit the motor to start do not protect the motor against burnout. A combination fuse and thermal relay such as the Buss Fusetron protects the motor and is inexpensive. If the motor does not have overload protection, the fuses should be replaced with overload relays or Buss Fusetrons. After installing suitable fuses and resetting overload relays, allow the machine to go through its operating cycle; and if protective devices again operate, check the load. If the motor is excessively overloaded take up with the appliance manufacturer.

2. Measure volts at motor terminals with switch closed. See that it is within 10 percent of voltage stamped on the name plate of motor.

3. Examine for broken wires, loose connections, which is indicated by humming sound when the switch is closed.

4. Requires motor built for operation on power supply available. A.C. motors will not operate on D.C. circuit.

5. Check condenser separately.

6. See that connections are exactly like connection diagram which is sent with motor.

7. If the motor starts idle, that is without any load connected to it, and if all the above conditions are satisfactorily met, then failure to start is most likely due to excessive load. To determine this definitely make or have a reliable electric shop make a test of starting torque. Fractional horsepower capacitor start-induction run motors have a starting torque of 400 percent or more of full load torque. If the load requires more than this a larger motor is required.

If this figure is 400 percent of full load and motor fails to come up to speed, consult the manufacturer inasmuch as this would indicate either a misapplication of the motor, resulting in too great a load, or an increased load due to faulty driven apparatus.

(B) Excessive Bearing Wear—Probable Cause:

1. Belt tension too great; unbalanced or out-of-line coupling; eccentric or too closely meshed gears.

2. Improper, unclean or insufficient oil.

3. Dirty bearings.

(B) Excessive Bearing Wear—Test and Remedy:

1. Belts, either flat or "V," should have only sufficient tension to prevent slipping. "V" belts usually require less tension than an equivalent flat belt. Slipping of belts will cause pulleys to heat (touch), squeak (sound) or burn belts (smell).

Fig. 13. Cream separator driven by electric motor having a variable pitch pulley for speed regulation.

In case of unbalanced or out-of-line couplings or eccentric or too closely meshed gears—correct mechanical condition.

2. The lubrication system of small motors provides for supplying the right amount of filtered oil to bearing. It is only necessary for the user to keep wool yarn saturated with a good grade of machine oil.

3. When bearings get clogged with dirt, motors may need protection from excessive dust. Application may be such that an especially constructed motor should be used.

(C) Motor Runs Hot—Probable Cause:

(Don't judge motor temperature by feel of hand. Measure it with a thermometer, and when electric motors are operating their temperature should not exceed that of room temperature by more than approximately 72° F.; for example, room temperature 70° F., safe operating motor temperature 142° F.)

1. Bearing trouble.
2. Short-circuited coils in stator.
3. Rotor rubbing stator.
4. Excessive loads.
5. Low voltage.

6. High voltage.
7. Incorrect line connections to motor leads.

(C) Motor Runs Hot—Test and Remedy:

1. See condition under B.

2. Shorted coil may be located by fact that one coil feels much hotter than other. Very great increase over normal magnetic noise may also indicate shorted stator.

3. Some extraneous matter may be between rotor and stator, or bearings may be badly worn.

4. Be sure proper pulleys are on motor and machine. Driving the load at higher speed requires more power. Take an ammeter reading. If curent draw exceeds name plate amperes for full load, heating is caused by the excessive current.

5. Measure voltage at motor terminals with line switch closed. Should not vary more than 10 percent from voltage stamped on name plate.

6. See No. 5.

7. Check with connection diagram sent with motor.

(D) Motor Burns Out—Probable Cause:

1. Frozen bearings.
2. Some condition of prolonged excessive overload.

(D) Motor Burns Out—Test and Remedy:

1. Causes may be same as under B.

2. It is important that the load be examined carefully before the burned out motor is replaced so as to locate and remove the cause of the overload. Certain jobs such as refrigerators will, under unusual conditions of operation, apply prolonged overloads which may destroy a motor and which may be difficult to locate unless examined carefully. On a job where, it is assumed, somewhat intermittent service will normally prevail and which consequently is closely motored, the load cycle should be especially checked, as a change in this feature will easily produce excessive overload for the motor. Examine carefully to determine mechanical condition of the driven appliance.

(E) Motor is Noisy — (See Instructions for Repulsion Induction Motors.)

Repulsion Start-Induction Brush-Lifting Motors

(A) Failure to Start—Probable Cause:

1. Fuses blown.
2. No voltage or low voltage.

3. Open-circuited field or armature.
4. Improper current supply—incorrect voltage or frequency.
5. Worn brushes or sticking brushes.
6. Improper brush setting.
7. Improper line connection.
8. Excessive load.
9. Shorted stator.
10. Shorted rotor.

(A) Failure to Start—Test and Remedy:

1. Check capacity of fuses. They should not be greater in ampere capacity than recommended by appliance manufacturer and in no case smaller than full load ampere rating of motor, and they should have a voltage rating equal to or greater than voltage of supply circuit.

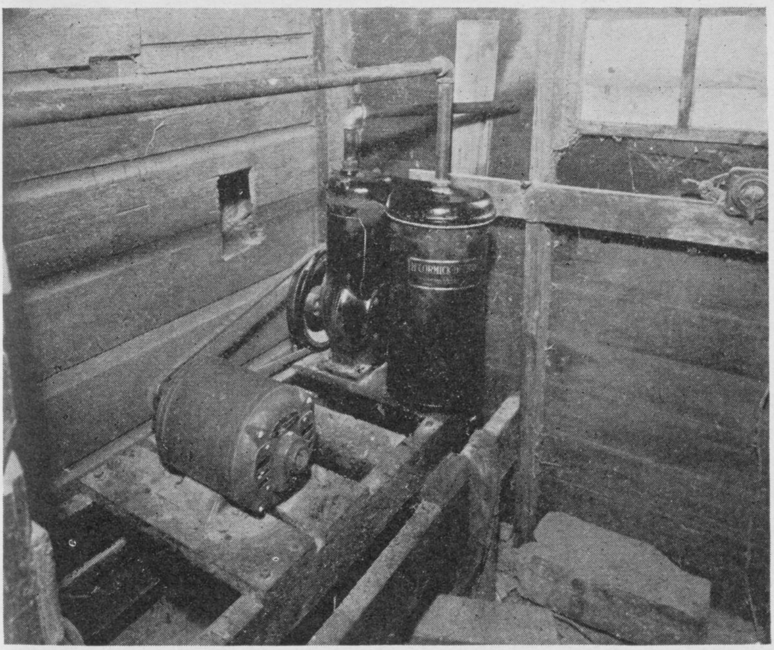


Fig. 14. Gas engine drive for this vacuum milking system has been replaced with ¾-horsepower electric motor. User says he wouldn't be without electric motor for his milker.

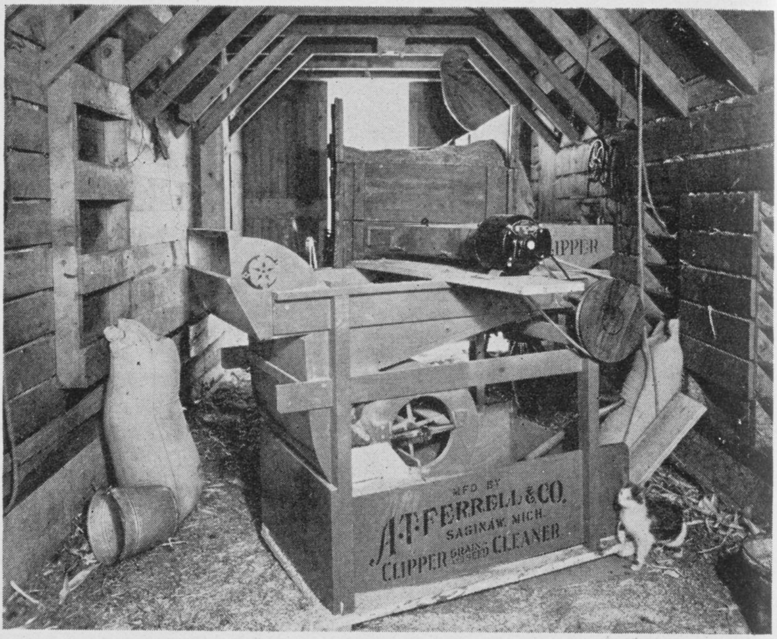


Fig. 15. Fanning mill converted by farmer to electric drive. This change means a great saving in time and labor.

2. Measure volts at motor terminals with switch closed. See that it is within 10 percent of voltage stamped on name plate of motor.

3. Indicated by excessive sparking in starting, or refusal to start at certain positions of rotor, or by humming sound when switch is closed. Examine for broken wires, loose connections or burned segments in commutator at point of loose or broken connection. Inspect commutator for foreign metallic substance which might cause short between commutator segments.

4. Requires new motor built for operation on local power supply. D.C. motors will not operate satisfactorily on A.C. circuit.

5. When brushes are not making proper contact with commutator, the motor will be weak in starting torque. This can be caused by brushes worn, brushes sticking in holders, brush springs weak or commutator dirty. Commutator should be polished with fine sandpaper (never use emery). (Commutator should never be oiled or greased.)

6. Unless a new armature has been installed, the brushholder or rocker arm indicator should be opposite index and locked in position. If new

armature has been installed, the best position may be slightly off original marking.

7. See that connections are exactly like connection diagram which is sent with motor. Motor may through error be connected for higher voltage and connected to lower voltage supply.

8. If the motor starts idle and if all the above conditions are O.K., then failure to start is most likely due to excessive load. To determine this definitely make or have a reliable electric shop make a test of starting torque. Fractional horsepower repulsion induction motors have a starting torque of 350 percent or more of full load torque. If the load requires more than this a larger motor is required.

If this figure is 350 percent of full load on a new motor (may be slightly less on a used motor) consult the manufacturer inasmuch as this would indicate either a misapplication of the motor, resulting in too great a load or an increased load due to faulty driven apparatus.

9. Best to check separate wattmeter reading on each of two halves of stator winding. Sometimes shorted coil may be located by fact that one coil feels much hotter than other. Very great increase over normal in magnetic noise may also indicate shorted stator.

10. Remove brushes from commutator and impress full voltage on the stator. If there are one or more points at which the rotor "hangs" or fails to revolve easily when turned, the rotor is shorted. By forcing the rotor to the position where it is most difficult to hold, the short can be located as the shorted coil will become hot. Do not hold in position too long or coil will burn out.

(B) Motor Operates Without Releasing Brushes—Probable Cause:

(Brushes should leave commutator in 5 to 10 seconds. Troubles result from delayed operation.)

1. Dirty commutator.
2. Governor mechanism or brushes sticking or brushes worn too short for good contact.
3. Frequency of supply circuit incorrect.
4. Low voltage.
5. Line connection improperly or poorly made.
6. Incorrect brush setting.
7. Incorrect adjustment of governor spring.
8. Excessive load.
9. Shorted stator.

(B) Motor Operates Without Releasing Brushes—Test and Remedy:

1. Clean with a piece of fine sandpaper. (Do not use emery.)
2. See that brushes move freely in slots and that governor mechanism

operates freely by hand. Replace worn brushes with new.

3. Run motor idle. After brushes throw off, speed should be slightly in excess of full load speed shown on name plate. An idle speed varying more than 10 percent from name plate speed, indicates that motor is being used on a supply frequency for which it is not designed, and a different motor will be required.

4. See that voltage is within 10 percent of name plate voltage with the switch closed.

5. See that contacts are good and that connections correspond with diagram sent with motor.

6. Check to see that brushholder yoke setting corresponds with index mark.

7. The governor should operate and throw off brushes at approximately 75 percent of speed stamped on name plate. Below 65 percent or over 85 percent indicates incorrect spring tension.

8. An excessive load may be started and not be carried to and held at full load speed which is beyond where the brushes throw off. Tight motor bearing may contribute to overload. This is sometimes indicated by brushes coming off and on commutator. See also (A)-8 above.

9. See (A)-9 above.

(C) Excessive Bearing Wear—(See Instructions for Split-Phase and Capacitor Motors.)

(D) Motor Runs Hot—(See Instructions for Split-Phase and Capacitor Motors.)

(E) Motor Burns Out—(See Instructions for Split-Phase and Capacitor Motors.)

(F) Motor is Noisy—Probable Cause:

1. Unbalanced rotor.
2. Worn bearings.
3. Rough commutator or brushes not "seating" well.
4. Motor not properly aligned with driven machine.
5. Motor not firmly fastened to mounting base.
6. Loose accessories on motor.
7. Air gap not uniform.
8. Amplified motor noises.

(F) Motor is Noisy—Test and Remedy:

1. When transportation handling has been so rough as to damage the heavy shipping case, it is well to test motor for unbalanced conditions at once. It is even possible (though it rarely happens) that a shaft may be sprung. In any case the rotor should be rebalanced.

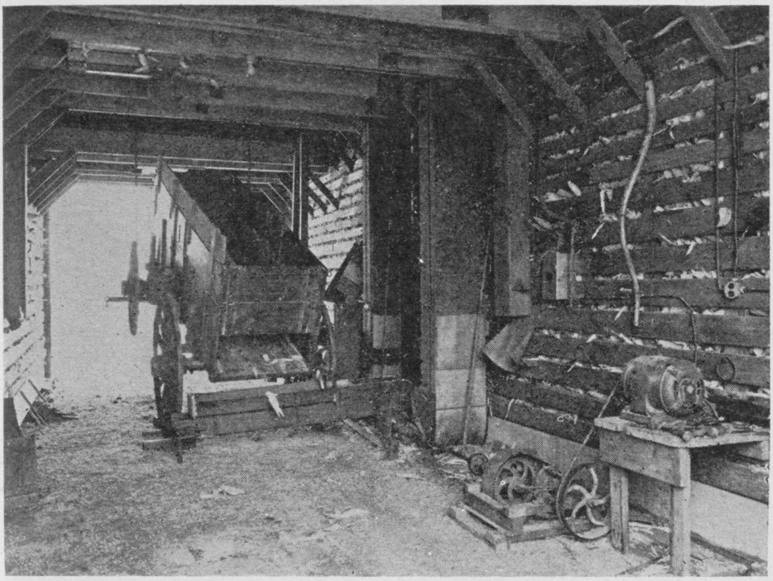


Fig. 16. Doing one of the hard jobs on a farm at an extremely low cost. User reports that less than $1.00 power is required to elevate the entire corn crop.

2. If unduly frequent, examine for cause. See (C) above.

3. This noise occurs only during starting period but conditions should be corrected to avoid consequent trouble.

4. Correct mechanical condition.

5. All small motors have steel bases so they can be firmly bolted to mounting without fear of breaking. It is of course not to be expected that the base should be strained out of shape in order to make up for roughness in mounting base.

6. Such parts as oil covers, guards, if any, on end plate, etc., should especially be checked for security if they have been removed for investigation of any sort. The condulet box should be tightened when top is fitted after connections are made.

7. This results from sprung shaft or unbalanced rotor. (See No. 1 above.)

8. When this condition is suspected, set motor on a firm floor, and if motor is quiet, then the mounting is acting as an amplifier to bring about certain noises in the motor. This may occur even though mounting is quite firm in structure. Frequently correction of slight details in

the mounting eliminates this but rubber-mounted type motors are almost invariably quiet.

(G) Excessive Brush Wear—Probable Cause:

1. Dirty commutator.
2. Poor contact with commutator.
3. Excessive load.
4. Failure to throw off promptly and stay off during the running period.
5. High Mica.
6. Rough commutator.

(G) Excessive Brush Wear—Test and Remedy:

1. Clean with piece of fine sandpaper. (Never use emery.)
2. See that brushes are long enough to reach commutator, that they move freely in slots and that brush spring tension gives firm but not excessive pressure.
3. If brush wear is due to overload, it can usually be checked by noting the time required for lifting the brushes from the commutator. Proper time is not in excess of 10 seconds.
4. Examine for conditions listed under (B) above.
5. Examination will show this condition, and the remedy is to take a very light cut off commutator face and polish with fine sandpaper.
6. See (5) above.

(H) Brushholder or Rocker Arm Wear—Probable Cause:

1. Failure to throw off properly and stay off during the running period.

(H) Brushholder or Rocker Arm Wear—Test and Remedy:

1. No noticeable wear on this part should occur during life of motor. Troublesome wear indicates faulty operation. See (B) above.